No. 51

June - July 1993

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the independent journal of energy conservation, building science & construction practice

Inside . . .

Summer heat waves happen every year, so when summer approaches, keeping cool (as opposed to keeping warm) is uppermost on everyone's mind. However, it seems that we are making things worse for ourselves, as our cities are overheating because of the way we build them. We present an interesting insight on this issue.

Roofing membranes usually will also provide waterproofing below ground. CCMC presents a review of the standards that apply to these materials.

The Innovative Housing '93 conference in Vancouver was an opportunity for researchers, designers and builders to mix and learn about the current activities in the housing sector. We present brief highlights.

Other items include a review of HRV system efficiency, window durability test results, monitoring results on the Brampton Advanced House, TRC news, and much more.

Contents . . .

Keeping Cool

From the Publisher . . .

In the past few years building technology has undergone many changes, largely as a result of the availability of new industrial processes and chemical compounds. Some of the changes have been driven by a greater emphasis on energy conservation and increased comfort. Others have been in response to a desire to provide more affordable options in materials and improve the speed of construction. The stress on energy conservation, caulking and air tightening of buildings has also meant that the physics of the building have changed.

At the same time we are discovering that many of the new materials we are using may not be healthy - in fact some of the materials could be toxic to the human body. We can survive without food for weeks time, we can survive without water for several days, but we can't survive without air for more than a minute or two. Over the course of a day we consume about 1 pound of food, 5 pounds of water, and 54 pounds of air. While much time and money is spent testing foods and products that are going to be in contact with food, we are not as sensitive to the invisible elements in the air.

The quality of indoor air is a major contributor to the health of our buildings. We are only now beginning to learn that many products affect the quality of indoor air and thus our health. The cause and effect is not as clear cut as for stuff we eat, so it has been difficult to come to terms with the issue. No product manufacturer will willingly admit that their merchandise may be the cause of some health problem. Certainly there are warning signs on many products about the need to wear protective gear when using the product, to use in a ''well ventilated space'' and so on - the theory being that once it has set it will be alright. But the length of time that those fumes are given off, and their strength is what is of concern.

I was heartened to note the amount of interest in these issues internationally. The technical sessions on healthy housing concerns at the Innovative Housing conference were extremely well attended. Similarly, the topic was raised many times at the low energy housing sessions at the Solar Energy Society of Canada conference in Quebec.

We must find means of putting into practice the knowledge that is being gained. Good quality housing must include concerns for the health of the indoor environment, not just structural strength and durability.

Richard Kadulski
Publisher

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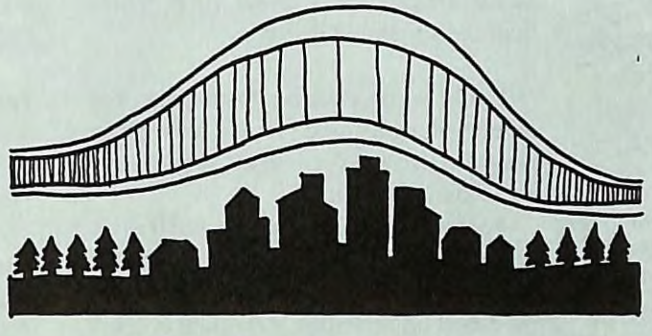
Keeping Our Cities Cool



In the heat of the summer, in the city, one's concern is how to stay cool. Those fortunate enough to be able to get away, or those who live in the country, generally don't suffer as much as those living in the city.

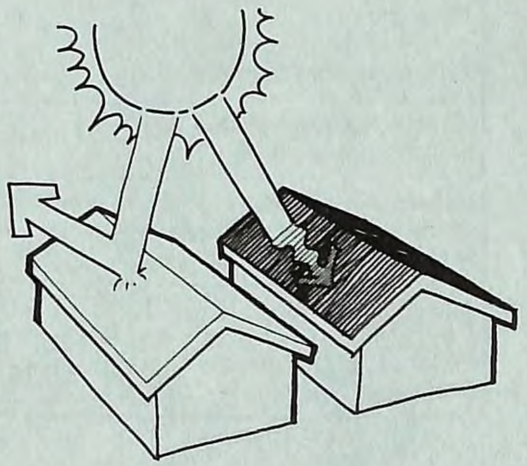
It has been well recognized for some time now that large cities are modifying the climate around them. Elevated temperatures in urban ''heat islands'' result in warmer winter temperatures than in the surrounding country side and more energy use in the summer for cooling. This large summer energy use also enhances the formation of urban smog.

How big an issue is it - especially in a cold climate such as Canada? *Ontario Hydro now experiences its peak energy demands in the summer!*

On a summer day, the average temperature in a typical North American city is about 5°F hotter than the surrounding rural area. Dark surfaces heat up as they absorb solar radiation, and with the reduced vegetation, contribute to what is termed the ''urban heat island.'' 5-10% of urban peak electric demand today is for additional air conditioning to compensate for the heat islands.

The power needed to compensate for heat islands requires significant additional generating capacity, which contributes to urban air pollution. Through the formation of smog and urban ozone. This contribution may be significant since peak power is often supplied by the most polluting power plants, often located right in the city.

Fortunately, there are simple solutions that can reduce the urban heat island effect at virtually no extra cost - just changing the materials used. Trees and light-coloured surfaces are inexpensive and effective ways to moderate the effect of urban heat islands. Light-coloured surfaces typically have a high ''albedo,'' meaning that they reflect a large percentage of the sun's radiation. Because they are good reflectors, they stay cooler than absorbing surfaces. This is why buildings in hot climates have traditionally been white washed for the summer.

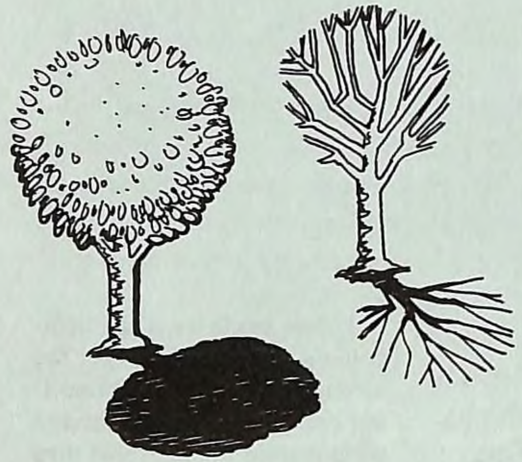


Urban shade trees and light-colours surfaces can lower the air temperature and reduce cooling energy use. Light-coloured surfaces stay cool because they typically have a high ''albedo'' and reflect solar radiation that would otherwise heat the surface.

Through direct shading, evaporation and transpiration, trees reduce summer cooling energy use in buildings at only about 1% of the capital cost of avoided power plants and air-conditioning equipment. Light-coloured surfaces are even more effective than trees at cooling cities and cost less if colour changes are incorporated into routine maintenance schedules. The results from light-coloured surfaces are immediate, while it may be ten or more years before a tree is large enough to produce significant energy savings. High-albedo materials on surfaces such as roofs, streets, sidewalks and parking lots, will be cooler than the moor conventional dark materials. Computer simulation of a house in Sacramento California has shown that applying a white coating to the roof and adding three shade trees can reduce the cooling electricity use by nearly 50%!

This means that if cooling is still needed, smaller capacity equipment is needed, so that not only operating costs but also initial capital costs can be reduced.

Increasing the albedo of a city may be inexpensive if the change is made routine maintenance. Buildings are typically repainted every 10 years; white paint doesn't cost more than any other colour. Many



roof types, including single-ply membrane and built-up roofing, are available in white for no additional cost. Light-coloured pavement could be installed at the time of resurfacing. "Whitetopping" (resurfacing an asphalt pavement with concrete) produces a light-coloured pavement that has low maintenance costs and a long service life. Another option for light-coloured pavement is a "hot-rolled" asphalt pavement using white aggregate. This paving method, popular in Great Britain, involves rolling chippings into the top surface of the pavement.

But what about winter heat gain? It has been a common belief that the use of darker materials will maximize heat gains for the building. The reduction in heat gain through the use of light coloured finishes is marginal as at our northern latitudes the winter sun is low and has a lower energy content. The beneficial heat gains are those through appropriately located and sized windows. The exterior finishes are on the outside of the insulation, so there is little impact if the surface temperature is higher.

If the concept sounds too simple or too good to be true, then a Lawrence Berkeley laboratory study currently under way may provide the proof. It is looking at air temperatures in the White Sands National Monument, a light-coloured strip several miles wide in southern New Mexico. The white sand is gypsum (quite white), and the vegetation is sparse. The difference in the absorptivity properties between the monument and the desert nearby is about 40% (or similar to the potential difference if a more spread out city like Los Angeles or Toronto were modified). Although the data are very preliminary, the light-coloured White Sands Monument is about 10°F cooler than the vegetated desert.

Using white surfaces to increase the albedo of urban heat islands may be an easy way to conserve energy, save money and reduce pollution.

For residential buildings, asphalt shingle and modified bitumen roofing should be targeted, while built-up roofing and modified bitumens are important in commercial applications. Labelling programs may be needed to identify the best materials for increasing albedo.

White asphalt shingles are in fact quite dark (75% absorptive,) when compared to white paint.

The accompanying table lists the approximate values for a range of common finishes and colours, as well as overall average city values. The higher the surface temperature or materials, the more the surrouding air temperature is increased (which is why the city centre gets hotter).

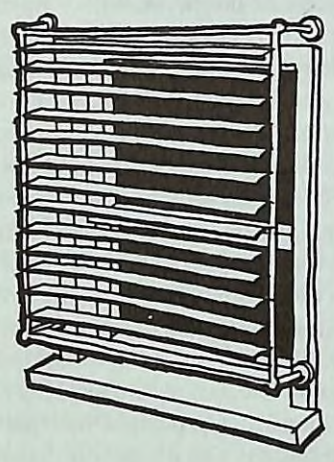
This item is based on the presentation made by the wrap up plenary speaker at the Innovative Housing 93 conference in Vancouver, B.C. June 1993

Mitigation of Urban Heat Islands: Materials, Utility Programs, Updates; Arthur H Rosenfeld, Hashem Akbari, Sarah Bretz, David Sailor, Haider Taha; Heat Island Group, Lawrence Berkeley Laboratory, Berkeley, California

ALBEDO (reflectivity) OF VARIOUS SURFACES

MATERIAL	ALBEDO	SURFACE TEMPERATURE
Black coating	0.1	190°F
"Average" city	0.2	
"white" asphalt shingle	0.25	175°F
Terra cotta tile	0.3	170°F
Grey weathered concrete	0.35	155°F
"Green" city (theoretical value for light-roofed city)	0.4	
Very light grey surface	0.5	135°F
light beige surface	0.65	125°F
Aluminum foil	0.85	120°F
White paint, anodized aluminum	0.75	110°F

Solar Shading Screens



Most energy conservation measures up to now have been concerned with reducing space heating and hot water consumption loads as these are generally the largest energy loads in Canadian homes. However, summer overheating and the resulting space-cooling energy loads can be significant.

There are several ways to reduce overheating and thus cooling loads. The first is to remember that for most new homes the single largest component contributing to cooling loads is solar gain through window. For homes which don't get external summer shading by architectural devices (e.g., overhangs) or adjacent vegetation, exterior solar shade screens should be considered. Interior shades or screens are OK, but not as effective as keeping the heat out in the first place.

A study was done by Unies Ltd. of Winnipeg to find out how effective screens can be. The design cooling loads were estimated for a typical 147 m² (1584 ft²) bungalow using various window types and glazing distributions.

In all the homes approximately 60% of heat gain was from unshaded windows. At all three locations and for all variables monitoring showed 1/3 reduction in cooling loads.

Analysis for three locations (Winnipeg, Montreal and Toronto) showed that in all cases the shade screens reduced the design cooling load by approximately one-third, roughly 1.8 kW (0.5 tons).

A series of field observations were made of the screens installed on four typical bungalows in Winnipeg. These showed that proper tensioning of the fabric mesh was required to prevent optical distortions, an improved system was needed for mounting the screens, house appearance was not negatively affected by the screens and that homeowner reaction to the screens was generally favourable.

The screens are high-density mesh mounted in easily removable frames on the exterior of the window. They are commercially available in vinyl, fibreglass, or metal in various colours, textures, and densities, with estimated retail costs of about $ 3.54 per sq. ft.. For a typical new home, depending on number and size of windows, the cost could range from $300 to $750. (Retrofitting is more expensive estimated to be two to three times greater).

Other screen types include retractable awnings or exterior mounted roll-blinds. Much cheaper, though maybe not as aesthetically satisfactory for all situations, are roll-up bamboo blinds.

Economic benefits include reduced capital costs by downsizing or eliminating air-conditioning equipment and reduced annual energy costs. Other benefits are reduced glare, increased privacy, reduced fabric fading and insect control. On the downside the screens have to be removed and re-installed seasonally, reduced visibility, and the appearance of the house. Although the latter two considerations were found to be highly subjective when homeowners were interviewed.

A Preliminary Assessment of the Solar Shade Screen System for Reducing Residential Cooling Loads prepared by Unies Ltd. Winnipeg, Manitoba for Efficiency and Alternative Energy Technology Branch/CANMET, Energy Mines & Resources Canada

Electronic Library of CADD Symbols

A new library of CADD (Computer-Aided Design Drafting) symbols on diskette has been released by CSA. This electronic file, called the *CADD Symbology Diskette for B78.5-93, Computer-Aided Design Drafting (Buildings)*, promotes the use of standardized symbols in technical drawings for buildings.

Sets of symbols on the diskette apply to the description of site, architectural, structural, mechanical, electrical and telecommunications specifications. Users can directly import the library of over 450 symbols into AutoCad and MicroStation or they can use the generic .DXF format provided.

The new diskette complements the recently revised CSA standard on the subject, *B78.5-93, Computer-Aided Design Drafting (Buildings)*.

For information:
Canadian Standards Association
Peter Nicol Tel: (416) 747-2629
Standard Sales Tel: (416) 747-4044

Refrigerator Energy Saver

Have you ever noticed how, when you open a refrigerator door, winter suddenly envelops your feet? That's because an avalanche of cold air slides off the bottom shelves, while warm kitchen air swoops in on top. Your refrigerator actually uses 20% of its energy to return to its proper temperature after people have opened and shut the door. Regardless of how efficient a refrigerator is, the energy wasted when the door is opened is considerable.

A new product for residential fridges is the CHILLshield. This product easily custom-fits in any size or type of refrigerator. Clear plastic flaps prevent cold air loss while allowing easy access to items inside.

Some grocery stores use a similar type of product on their coolers and freezers. CHILLshield reduces the energy use, saving money and extending the life of a refrigerator by reducing the compressor operation time, also reducing condensation build up.

The distributor claims that depending on refrigerator type, efficiency, family size and habits the energy saving is from 300 to 500 kWh, per year (at $0.08/kWh this represents a saving of $ 24 to $ 40).

For information:
R & S Products Limited
1 Church Street, Unit 10
Keswick, Ontario L4P 3E9
Tel: 1-800-263-2054
Fax: (416) 476-0475

HRV system efficiency

Do heat recovery ventilators actually deliver their advertised performance?

Field tests have shown that as installed HRVs usually are less efficient than claimed. A typical best case installation was actually recovering 50% of the heat (at -25°C) compared to test results of 59%, and 75% at 0°C (compared to published results of 83%).

A study by ORTECH International of Mississauga, for CANMET investigated the impact of poor ductwork installation practices on energy transfer from a conditioned air space into a residential HRV system. To quantify the energy gains and losses associated with HRV ductwork, the study was designed to identify the sections of ductwork which impact the overall energy performance of an HRV, to determine the recommended and actual configurations of these sections and determine the performance of these sections through laboratory simulations.

The results showed that there are only marginal differences in duct energy gains between flexible and rigid ducts when both are insulated at the same level and that duct configuration (number of bends and elbows) has minimal effect on energy gains at constant airflows. However, it was found that in straight duct configurations flex duct would produce about two times the static pressure of rigid ducts. In configurations with bends and elbows, flexible duct had about one and a half times the static pressure.

Flexible duct in straight configurations with sags to simulate bad installation practices had approximately four times the static pressure of rigid duct.

The recommended installation practices are summarized in the table.

Recommended installation practices suggest the following be kept in mind when layout ventilation systems	
Duct runs	kept as short as possible
Duct size	sized for the required ventilaiton flows
Duct sealing	tape or caulk
Number of bends	kept as few as possible
Insulation	minimum of R4
Duct type	preformed rigid or flex duct if needed
Vapour barrier	Poly of metalized film on cold side of duct

Conclusions of the study were that typical HRV installations are subject to enough heat transfer through the cold side ducting to have a major effect on energy performance.

Extremely long duct runs, caused by poorly located HRVs (i.e. in the middle of the house, rather than against an exterior wall) will determine how much heat recovery there is, and not the number of bends and elbows. In addition, energy loss into the ducting is a factor of insulation level and effectiveness of the vapour barrier. If the vapour barrier does not do its job, then there will be condensation in the insulation and further deterioration of performance.

This suggests a general per foot adjustment factor for HRV and airflow rate will have to be developed for prediction of performance.

The second conclusion was that since flex duct was found to be so much easier to install properly than rigid duct, the energy impacts of reduced airflow caused by increased static pressure for flex duct are offset by the reduced potential for thermal losses.

The final conclusion was a recommendation that appropriate correction factors be developed/incorporated into the HOT-2000 energy analysis program so that HRV performance estimates reflect the effects of duct energy transfers.

Study of Residential Ventilation Duct Energy Losses prepared for Efficiency and Alternative Energy Technology Branch/CANMET, Energy, Mines and Resources Canada by ORTECH International, Mississauga, Ontario

Roofing and Waterproofing Membranes

The Canadian construction industry is beginning to recognize that a roofing product can also be an excellent waterproofing product for the protection of basement walls and underground structures. Canadian Construction Materials Centre (CCMC) evaluation listings have always acknowledged that roofing and waterproofing membranes share a basic similarity of function; to keep water out of the structure on which they are installed.

They meet certain fundamental parameters:

- they must be able to be installed in such a way as to form a continuous, impervious membrane; this is accomplished by either having no joints (liquid membranes) or joints that can be effectively sealed to provide a similar effect.
- they must be capable of bridging cracks that may occur in the structure.
- they must be able to resist impacts (toughness) and remain flexible during installation, such as during backfilling or the application of granular topping, and during their application exposure. For some of these materials, the most severe exposure will be to extreme cold temperatures and the foot traffic that can occur during maintenance of roof mounted equipment.
- they must have the ability to remain in place, either by their inherent adhesion qualities or by being mechanically fastened, depending on the application of both roofing and waterproofing materials.

Four Canadian product standards are currently applicable to both roofing and water proofing materials:

CGSB 37-GP-56M; Modified Bituminous Roofing Membranes: at this time only recognizes these as roofing materials.

CAN/CGSB-37.50-M89, Hot-applied, Rubberized Asphalt for Roofing and Waterproofing.

CGSB 37-GP-52M (1984), Roofing and Waterproofing Membrane, Sheet Applied, Elastomeric.

CGSB 37-GP -64M (1979), Roofing and Waterproofing Membrane, Sheet Applied, Flexible, Polyvinyl Chloride.

CAN/CGSB -37.58-M86, Membrane, Elastomeric, Cold-Applied Liquid, for Non-Exposed Use in Roofing and Waterproofing.

Installation

Proper installation is critical to the performance of roofing and waterproofing products. For this reason, manufacturers have detailed installation instructions and most limit installation to personnel they have trained and certified. For more information on products which have been evaluated by CCMC for roofing and waterproofing applications the reader should consult CCMC's Volume 2 of Evaluation Listings.

CCMC, Institute for Research in Construction; National Research Council of Canada; Ottawa, Ont. K1A 0R6
Tel: (613) 993-6189
Fax (613) 952-0268

Healthy House Building

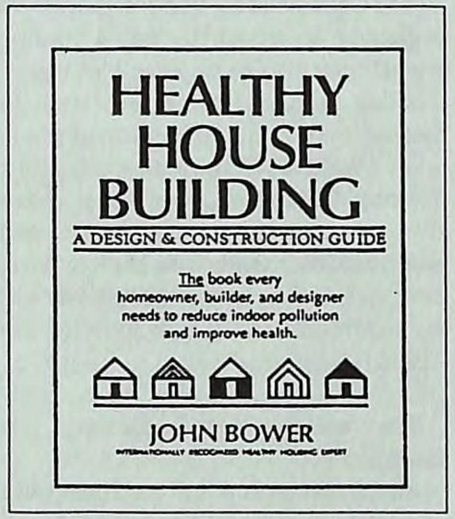
Indoor air pollution is a growing problem around the world. Last year CMHC focused attention on the issue through their Healthy House competition. In addition, they have a number of studies and projects under way to improve our knowledge of the problem, identify resources, and areas for further research.

It is estimated that in the United States poor indoor air quality accounts for 50% of all illnesses. In addition, about 15% of the U.S. population have increased allergic sensitivity to chemicals commonly found in household products. The figures for Canada would not be much different.

Many building materials such as paints, caulks and glues release organic solvents when curing. This process can last many months, during which the organic vapours may cause odours, headaches, allergic reactions, bronchial complaints and permanent respiratory damage. Thousands of chemicals, some toxic and many never tested for toxicity, are present in household products ranging from paint strippers to insecticides to deal with these issues.

A number of builders are starting to specialize in healthy building projects. One of these who has received considerable exposure is John Bower, an Indiana builder. Along with his wife he has established the **Healthy House Institute** with the object of helping to improve the air quality in houses and as a result, the health and well being of the occupants of those houses.

The Institute provides consultation services as well as a series of in-depth Healthy House Reports, books and videos to designers, builders, and home owners on topics related to healthier construction practices and life-styles.



The Healthy House Reports are designed to supply solid hands-on information for anyone concerned about their indoor environment. Three reports have been published to date:

The Unhealthy House

(Report 101, 4 p. US $ 2.50)

Describes the problems associated with poor indoor air quality, including the primary culprits and the health consequences.

Furnishings

(Report 102, 12 p. US $ 4.50)

Guidance in selecting healthy furnishings for every room of the house

Painting

(Report 103, 16 p. US $ 5.50)

Why you should be concerned about the negative health effects of paints, finishes and strippers, and how to minimize your risk.

In addition, they have just published a step-by-step illustrated **Healthy House Building** a design and construction guide. This book covers all aspects of the design and construction of a model healthy house, including material selection, structural design, ventilation and filtration systems, and interior finishes. A companion to the book is a 27 minute video titled **Your House, Your Health: a Non-Toxic Building Guide.**

While some of the discussion about the need and how to detail airtight construction and installation of mechanical systems are well understood by R-2000 builders, the book and video presents the hands-on experiences of one builder.

For information,
The Healthy House Institute
7471 N. Shiloh Road
Unionville, IN
47468
Tel: (812) 332-5073

German Energy Codes: 30% Energy Use Reduction

New regulations in Germany require that starting in January 1995 new construction must reduce space heating energy consumption by 30%. By the year 2000 that is slated to increase to a 50% reduction over present usage. At present energy consumption is in the 130-180 kWh/m^2 range. The goal is to reduce space energy consumption to about 54-100 kWh/m^2.

By comparison, an average R-2000 house uses 104 kWh/m^2 and the Advanced Houses are designed to use 52 kWh/m^2.

HOT 2000 (v 6.0) USERS:

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You know that the program requires lots of input information. You can save time, improve accuracy, and have a neat record of all the inputs when you use ou Data Input Sheet.

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RESIDENTIAL VENTILATION: Achieving Indoor Air Quality

The original Canadian book that tells designers and builders how to deal with indoor air quality issues. It describes why ventilation is necessary and how it can be provided, effectively and without creating discomfort.

Key principles of ventilation systems are laid out in very simple language. By Richard Kadulski, illustration by Terry Lyster, technical consultant David Hill

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by W.D. Lewicky, P. Eng

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Air Distribution in Rooms **4th International Conference ROOMVENT '94** Cracow, Poland, June 15 to 17, 1994.

Air movement in rooms: topics such as modelling and prediction of airflow patterns, optimization of energy consumption and consideration of thermal comfort within large spaces as well as of residential buildings.

Information: Roomvent '94
Department of Heating, Ventilating and Dust Removal Technology
Silesian Technical University
Pstrowskiego 5
44-101 Gliwice, Poland

Window Durability

Any moveable product is subject to wear and tear over time. Windows are perhaps the most prominent component in the building envelope exposed to such stresses. In addition to people abuse, windows are subject to constantly changing wind pressures from different directions and intensities.

How well do different windows stand up?

A study to determine the long term effects of such pressure cycling on the performance of various window types was done by Air-Ins Inc of Quebec for CANMET. Four types of wood, aluminum and PVC window frames (casement, vertical slider, horizontal slider and fixed) were tested for ease of operation, air leakage, resistance to water penetration and condensation resistance. All windows were tested when new, after pressure cycling through 500 cycles of alternating pressure (+1.2 kPa and -1.2 kPa or ±25 psf), after 1000 cycles, and finally after 2000 cycles.

Ease-of-operation tests showed that all window frames except the aluminum vertical slider were deformed somewhat over time as they required more force to open the sash and maintain motion. These increases ranged from 23% to 194%. PVC casement windows showed the largest deformation, as they had the largest increase in the force required to open the windows.

All windows became leakier over time. Air leakage increases ranged from 8% to 275%. The largest increases were for the PVC windows. Most of the increases seemed to be caused by a combination of factors including the compression set of weather stripping, creep of the vinyl sash members, and lack of rigidity of sash members.

The resistance to water penetration of most samples did not change.

Condensation resistance tests showed that even in wood and PVC frame windows the interior frame surface temperatures can be lower than the minimum acceptable level. These low frame surface temperatures happen because of cracks which develop between the sash and frame.

The study recommended that:

1) pressure cycling be incorporated into the Canadian standard to insure durability of new windows,

2) condensation resistance tests be conducted on wood and PVC as well as on metal frame windows,

3) to improve the certainty of the performance levels given by CCMC an independent certification system should be put in place.

A Study of the Long Term Performance of Operating and Fixed Windows Subjected to Pressure Cycling. Prepared for: Efficiency and Alternative Energy Technology Branch/CANMET, Energy Mines & Resources Canada by: Air-Ins inc. Varennes, Quebec.

R-2000 Program Update

The mission of the R-2000 program is *to promote the energy efficiency of Canada's new housing stock through an industry-led, market-driven, leading edge housing standard presented as a cooperative partnership of the private and public sectors.*

1992/93 was a good year for the R-2000 Program, when over 1200 new homes were certified. There are now over 25 partners supporting the program.

One of the barriers to increased sales of R-2000 houses is the perception that they are too expensive and not worth the extra cost (usually 2 to 5% more than a conventionally-built house). A study was commissioned to determine the extra costs, and to weigh this against the value of the benefits of an R-2000 home. This study will be released in the summer of 1993. A new fact sheet entitled "The R-2000 Home - Is it Worth it?" will be produced, aimed at the potential home buyer.

Starting in 1993, a new tagline - "The R-2000 Home: More than Energy Savings" - is being used to build greater consumer demand for the many benefits R-2000 can offer. To convey this enhanced message, a comprehensive plan of marketing activities was launched in the spring of 1993. It zeroed in on the R-2000's three major benefits: environmental responsibility, energy efficiency and leading-edge technology.

EMR/CANMET NEWS

The Canada Centre for Mineral and Energy Technology (CANMET) is the research and development arm of Energy, Mines and Resources. EMR/CANMET's Buildings Group works with industry to develop and commercialize the technologies to make Canadian houses more energy efficient. With the support of the Buildings Group, Solplan Review presents this information on some current CANMET projects. For more information contact: Energy Efficiency Division, EMR/ CANMET, 580 Booth St., Ottawa, K1A 0E4.

Innovative Housing '93 Conference

One of the most important conferences in a number of years for the housing sector took place in Vancouver June 23 - 25, 1993. The Innovative Housing '93 conference attracted 700 registrants from 25 countries, and 200 speakers from 22 countries made presentations in 36 parallel sessions.

In addition to the technical sessions, and the opportunity to exchange information with others, there were 30 exhibits and tours to the B.C. Advanced House and the Vancouver Healthy House. And of course, Vancouver itself dazzled visitors in the sunshine.

With so many presentations, it is impossible to summarize what went on. Presentations were grouped in 4 general streams: technology innovations, planning and design issues, applications and demonstrations, and programs. A few highlights from some of these presentations follow.

Technology

Housing represents 20-30% of total energy use in the industrialized countries (the OECD countries). Systems engineering with meticulous attention to detail can lead to major energy savings (up to 90%) without significant cost increases. To encourage greater and faster adoption, energy efficiency needs to be linked to its environmental impact.

Significant progress has been made in low impact materials, construction waste management, and materials with high recycled content. Water consumption can be reduced by more than 40% using presently available technology.

Healthy Indoor Environments

A significant emerging trend is a greater interest in healthy building environments. There is a growing awareness that there is more to a building than just a roof to keep out the rain. The cause and effect relationships between tight energy efficient buildings and indoor air quality are being challenged - it depends on how the building is put together and how it is managed. Source control remains a key - careful selection and use of materials is important to maintaining healthy environments. Similarly, ventilation strategies are influenced by more than energy efficiency.

Housing for the environmentally hyper sensitive presents enormous challenges for builders and designers, as there is still great lack of understanding in the linkage of health to housing- knowledge demand exists

Planning and Design

World energy use is forecast to continue growing until 2010, with a 46% increase in CO_2 emissions (contributing to global warming). Yet 50 - 75% of total energy usage is influenced by the form of the built environment. There is a strong correlation between density and energy usage. The growth of suburban fringe won't stop, but can it be done more sustainably? In the 5 years since the Bruntland Report on the need for "sustainable" development a consensus has emerged that uncontrolled growth must be contained, but there is a big gap between the rhetoric we hear and reality.

Much greater use could be made of passive solar in terms of orientation and unit design. House designs need to be flexible to meet changing family structures. Working at home offers potential to reduce transport impacts. There is a need to raise public awareness of advantages of the innovative planning examples, and incorporate early public involvement. Land use standards (still are based on 1950's thinking) have to change to meet current realities.

Applications and Demonstrations

Demonstration projects are effective communications and education tools. Most demonstration projects are reducing the annual energy consumption below 50 kWh/m², while integrating the use of existing technologies can reduce consumption to 30 kWh/m². Further energy consumption reductions require seasonal storage.

Major demonstration projects in Canada and overseas have focused attention on the design community, the building industry and consumers. They involve partnerships of published and private sectors. Common features of many demonstrations include: high insulation levels, airtight construction, high performance windows, heat recovery ventilation, active and passive solar, photovoltaics, integrated mechanical systems, energy efficient appliances and lighting, use of recycled materials, water conservation, passive cooling, building automation, grey water heat recovery, and solariums.

Programs

Consumers are increasingly becoming aware of the major global issues. However many countries have experienced major increases in energy usage, especially electricity, since the fall of energy prices in the 1980's.

Many home energy rating systems are being developed (there are over 20 home energy rating systems in use in USA). Some are being tied into mortgage financing of new housing stock. Many demand side management (DSM) programs are being implemented, with utilities being in the best position to be champions for wise energy use. Training, inspection and commissioning are essential to ensure that the installed DSM measures actually perform as intended. Consumer information needs could be augmented with incentives, on-site advice and community based approaches.

A full set of proceedings will be published later this fall. We will keep readers infoormed when details are available.

Brampton Advanced House Performance

In 1989 the "Advanced House" in Brampton Ontario was built to demonstrate innovative residential energy-efficient technologies. This house is Canada's contribution to the International Energy Agency's Task XIII program focusing on Advanced Solar/Low Energy Residential Buildings. It was the catalyst for Energy, Mines and Resources Canada Advanced Houses Program begun in 1991.

Monitoring of the house performance began in the summer of 1990 and continued until October 1992. The performance of this, the first Advanced house, is particularly important as there are now ten second generation Advanced Houses completed and soon to be monitored. The results of the monitoring will provide feedback on performance of innovative products and technologies and data for establishing realistic expectations for any upgrades to the R2000 Technical Standards.

It must be remembered that the Brampton house project was first conceived several years before construction started, so some of the concepts and technologies used by the time of construction were not as innovative as they may first appear.

The Brampton House was designed to use 12,500 kWh per year or 31 kWh/m² of floor area (in a 4200°C degree day climate). This is about 30% the energy consumption of a similar house built to the 1985 insulation standards of the Ontario Building Code and using conventional mechanical systems.

Building envelope heat loss coefficient (199 W/°C) and airtightness (0.9 ACH at 50 Pa) were well within design targets, although some decrease of building airtightness was noted over time.

Indoor air quality tests showed that formaldehyde at 0.048 ppm and radon at .002 WLU are well within accepted guidelines.

Hot water use for the three person family averaged 164 litres/day at 45°C. Use of water-conserving appliances reduced water heating requirements to 60% of a typical residential load. Cold water use was 260 litres/day. In addition 140 cubic meters of water was dumped during the cooling season to maintain temperatures in the integrated mechanical system (IMS).

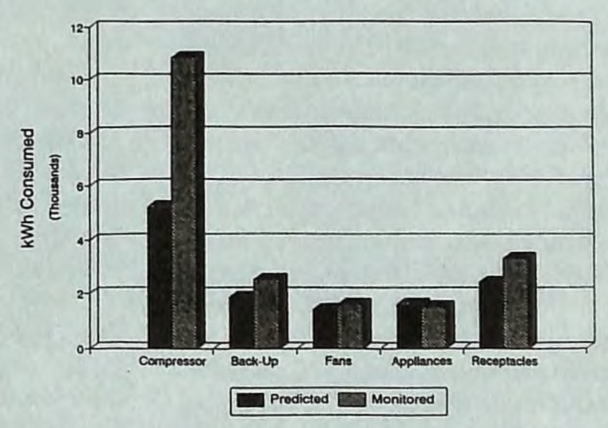
Lighting (non incandescent) and receptacles used 400 kWh/yr, 60% higher than predicted.

Total house performance.

It is here that the major lessons lie.

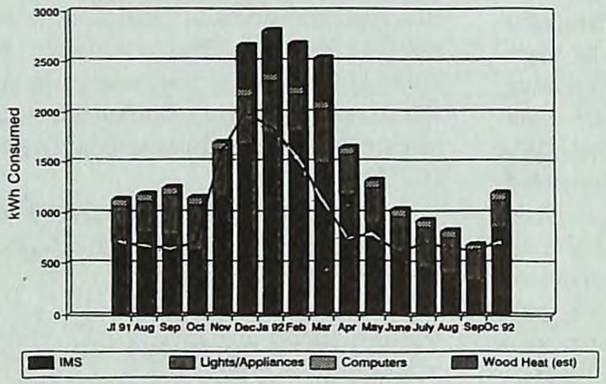
Monitored energy consumption was 28% higher than computer-predicted values during the demonstration period and 60% higher than predicted when the house was occupied. The annual energy use during the occupied period was 19,834 kWh or 49 kWh/m² of heated floor area (compared to the design target of 12,500 kWh).

The monitored compressor and pump energy use is the major cause for this unexpectedly high energy use - more than double predictions.



Comparison of predicted and monitored energy use

Why? The integrated mechanical system (IMS) is comprised of a hot water tank and a cold water tank thermally connected by a heat pump. Space heating is provided by a pump which circulates water from the hot-water tank through the



House total energy use (house occupied). The line shows the predicted preformance

heat pump condenser to a fan coil. Air circulated over the fan coil delivers heat to the home. Ventilation air is drawn in through the sunspace for passive solar preheat and delivered through the return air system.

The monitoring report suggests several reasons for the 35% higher than expected space heating loads and lower than expected system performance.

Occupant use: The average air temperature was maintained by the occupants at 23°C, not the 21°C temperature on which predictions were based.

Design related factors: Two problems were identified with the sunspace and both combined to result in a higher than expected ventilation air heat load.

The air leakage through the six sets of French doors connecting the house to the sunspace was significant. The air flow of fresh air into the sunspace from outside is only half the design value. As a result only 45% of the air being pulled into the sunspace is from outside, the rest is leakage from the house back into the sunspace. The net result is that only 15 L/s of supply air is fresh, outdoor air preheated by the sunspace and 53 L/s of supply air comes from infiltration through the building shell. This would account for the occupant's complaints of stuffiness and the need to increase the ventilation from the design rate of 68 L/s (the CSA F-326 Standard requirement) to 87 L/s. This increase in ventilation rate would then increase heat load over design predictions.

Integrated Mechanical System performance: The predicted Seasonal Performance Factor (SPF - the measure of the performance of the entire system relative to the load placed on it) was 2.0, but was monitored at 1.54. This lower SPF is largely due to a heat output of 4 - 5.5 kW rather than the 6 kW expected. This was traced in part to the lower house airflow circulation and also meant that more back-up (electrical or wood) energy was used than predicted. In addition high parasitic energy requirements (energy used by pumps and fans) represent 30% of total house energy consumption.

It should be noted that despite the higher than predicted energy use, at 49 kWh/m² per day the Brampton House still uses less than half the energy of an average R-2000 home. Both the integrated mechanical systems and other commercially available energy saving products significantly reduced energy consumption.

The monitoring shows that extremely energy-efficient buildings are achievable. As the industry uses the Advanced House monitoring programs to fine-tune the designs and systems used in these buildings, it should become easier to increase energy savings.

Performance Of The Brampton Advanced House, prepared for the Efficiency and Alternative Energy Technology Branch/ CANMET, Energy Mines & Resources Canada by Enermodal Engineering Ltd., Waterloo, Ontario.

CCMC Referenced in Ontario Building Code

Building codes and regulations set out the minimums required for a given construction assembly. Rather than spelling out the details, where appropriate standards have been developed by other agencies they are referenced, so that even if they are not typed out in the code, they become a part of the code. Typical are those standards developed by the Canadian Standards Association (CSA), the Canadian Government Standards Board (CGSB), and Underwriters Laboratories (UL).

A testing program, formerly run by CMHC and now taken over by the National Research Council, known as CCMC (Canadian Construction Materials Centre), is important as it is the basis for approved lists of products and building systems that are accepted for projects financed by CMHC.

Manufacturers and distributors have relied on this review as an official seal of approval. However, CCMC test results have never been an accepted standard in the Building Code. The difference may be subtle, but important, because for some materials and systems (especially new products) there are no applicable standards, so agencies such as CCMC do tests that follow conventional engineering procedures that may be reasonably close to standard practices, but they still do not conform to any applicable standard.

Building officials may have used CCMC test results as a reference when evaluating a product as an equivalency, but there was no obligation to do so.

This is about to change in Ontario. An amendment to the Building Code Act designed to facilitate innovation in the building industry, will designate CCMC in the 1993 Ontario Building Code as an accepted materials evaluation body.

Technical Research Committee News

Canadian Home Builders' Association

The Technical Research Committee continues to work hard to deal with the real priorities of the housing industry. This effort is ensuring that the needs of builders in the marketplace are given priority by those in the research and regulatory communities.

Among other issues, TRC's representations have resulted in appropriate research to resolve new requirements for wood trusses, and for fire and sound rated assemblies which rely on gypsum board (most residential assemblies).

TRC is planning to respond, during the public comment phase, to the many changes proposed for the 1995 edition of the National Building Code of Canada. (There are some 1,200 changes).

CHBA Builder Manual (New Edition)

A new edition of the CHBA Builder Manual is underway with completion now slated for this fall. This update will include the latest information on R-2000 and include more environmental information.

Builder's Guide to Environmental Products

Production of this guide is now underway, with the support of CMHC and the Ontario New Home Warranty Program and should be completed fall.

Hazardous lands.

The CHBA *Position Paper on Government Policies, Procedures and Criteria for the Clean Up of Contaminated Sites* is a document which identifies the key issues around hazardous lands.

An *Evaluation Protocol for Site Toxicity* summary will be released in Fall 1993.

CMHC is continuing with work on this issue. One project was a cross-Canada survey of houses which have been affected by hazardous lands where toxic vapours were present in the homes. Based on the survey results CMHC looked at the techniques which have been used to mitigate the indoor air quality and found that there was a great deal of confusion about aspects of the monitoring and there were conflicts over the interpretation of results. It was difficult to correlate what was happening in the soil outside the building envelope with the indoor air quality. Part of this was because essential information was not always collected and put together in the proper way.

A longer term detailed assessment of that particular problem will be made; four houses in Canada have been selected. Measurements will be done over a year taking into account barometric changes occurring in the winter months. What is going on in the soil and what is going on in the house will be monitored, as will various techniques of collecting data.

To deal with the lack of adequate education regarding toxic gases in housing, especially noticed at municipal levels (where authorities have to deal with this issue), CMHC is working on a Guide for Municipalities. This document will talk about the nature of soil gas problems, the types of soil problems which exist, how they originate, how they enter the building, how and why to monitor and what has to be done to remedy buildings. It will include a commentary on the legal aspects of a house situated on hazardous land.

Gas Equipment Venting Tests

The Canadian Gas Research Institute has undertaken a Gas Appliance testing program that was initiated at the request of the Ventilation industry to answer questions regarding the depressurization characteristics of side wall vented furnaces and hot water heaters. This study has been expanded to include fireplaces and gas dryers. Results should be available soon. Performance properties of direct vent and power vented appliances are important to know as other exhaust fans in a home are capable of creating large negative pressures, so that backdrafting of these appliances could still be a problem.

Materials Emissions Testing

The Institute of Research in Construction is initiating a five-year project on material emissions to study the emission characteristics of various building materials and furnishings, and their effects on indoor air quality. The main objectives of this project are to develop procedures for measuring the emission characteristics of various building materials; to develop a database of measured emission characteristics for various building materials and furnishings; and to develop a model for predicting the concentration of contaminants in a building.

To contact the TRC: Canadian Home Builders Association, Suite 200, 150 Kaurier Ave. West, Ottawa, Ont. K1P 5J4
Tel: (613) 230-3060
Fax: (613) 232-8214

SESCI Autonomous House Award

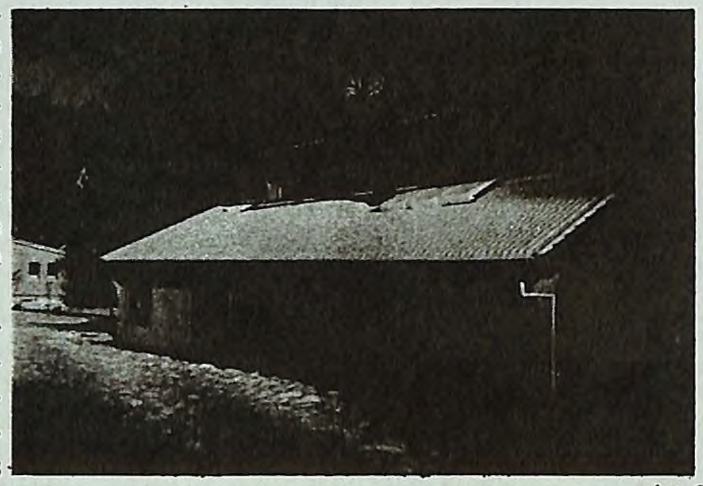
for environmentally-sensible zero-energy Canadian homes

We are facing major environmental problems caused in large part by the excessive use of inappropriate energy sources and materials. Programs such as R-2000, the Advanced Houses, and other individual demonstration houses receive a lot of attention, but these are biased towards expensive high-tech demonstrations.

These are fine when the principal players are government agencies, industry and utilities with substantial resources to invest. However, there are many individuals who, without any fanfare, are already building and living in some extraordinarily energy efficient homes that are well insulated, very energy efficient, taking advantage of solar energy as well as incorporating other environmentally sensible measures such as water conservation, resource efficiency and recycled materials. The public seldom hears about these houses because they are usually built on a low budget without the glamour features that attract media attention, and at times in out of the way places.

In order to demonstrate the technologies that are working now, the Solar Energy Society of Canada (SESCI) decided to give recognition to the efforts that are being made by individuals. That is why SESCI established the Autonomous House Award.

The objective is to encourage the adoption of appropriate conservation and renewable energy technologies by showcasing built examples that best approach zero non-renewable energy consumption and do not neglect other aspects of environmental sustainability.



Parker residence, Victoria 1993 winner of the Autonomous House Award

Any house in Canada that is lived-in year round, new or old, single family, semi-detached or row housing, with a proven performance of very low purchased energy consumption, along with other environmentally sensible features is eligible. To qualify, entries must have been lived in for at least one year, and the purchased energy consumption must be verified by an energy professional.

Judging criteria are not limited to energy performance. Factors that are considered by the jury include:

Energy use: how little purchased non-renewable energy is used? How little wood?

Materials: are materials and technologies used in and around the house environmentally appropriate?

Lifestyle & Design: does the house meet the needs and expectations of its occupants? does it meet accepted standards of comfort and lifestyle?

Implications: what is the likely overall environmental impact of the house over its lifetime? What is the potential for imitation and duplication of concepts by others?

Overall concept

Parker Residence Construction Specifications	
Roof	R32 fiberglass (nominal); poly vapour barrier
Walls	R-20 fiberlgass (2X6), plus 1/2" foil-faced poly-isocyanurate (Thermax)
Windows	sealed, double glazed, 1/2" airspace
Shutters	R-6 nominal (plus foil facing both sides insulation) - covered with fabric
Floor slab (slab-on-grade)	R10 extruded polystyrene under entire slab area; R20 on all slab edges, protected from sunlight

The first award was given in 1992 to Robert Fraser of Halifax. The winning entry was for the renovation of an older bungalow that has been retrofitted over the years.

1993 Autonomous House Award

The 1993 Autonomous House Award was given to Gil Parker of Victoria. The house, located in a rural area of the Saanich peninsula near Victoria would not look out of place in any town. It is a one and one half storey, 2312 sq.ft. slab-on-grade single family home that includes a home office - the owner works from home.

This house, built in 1986, was designed as an R-2000 house, but it emphasizes use of passive solar heating, storing heat in an interior brick wall and an insulated concrete floor slab. Back-up heat is provided by a wood burning stove (using on average 100 cu.ft. of wood from the site) or electric forced air furnace. Fresh air is supplied through a separately ducted vanEE 2000 HRV. The windows have insulating shutters that are used during night time from November to the end of March.

Hot water is provided by a solar hot water system supplemented by a coil from the wood stove.

Water conservation is promoted using low-flow shower heads, low flush (2.5 gallon/flush) toilets.

The roof is made of concrete tiles and rain-water is collected in a 4000 litre cistern for irrigation and (in emergencies) could be used for domestic use.

For health considerations, formaldehyde adhesives were avoided in all interior framing and cabinets were built from solid wood. Floor finishes are mostly ceramic tile and some cushion vinyl.

Energy use: the average total purchased energy over the past three years is 6550 kWh/yr. During this time 2 persons lived in the house continuously and one intermittently. Many visitors are hosted thus adding to the hot water load. The minimum indoor temperature is 17°C, but as the house is used for business as well as residence, the usual temperature is kept higher.

Jury comments

The jury had a difficult time in making their selection from among a number of strong entries (two were located entirely off the grid, thus had no purchased energy!).

They were suitably impressed with the overall concept of the Parker residence, in particular as the energy consumption was so low even with a full time office in the house. The fact that this house was built 7 years ago was taken into consideration. Materials selections and design concepts are used that only now are becoming more widely available or understood. The home office addresses concerns of impacts on the transportation infrastructure.

The attractive design of the house furthers the objectives of the award program, showing that energy efficiency can be achieved in an attractive home without requiring the homeowner to make severe lifestyle changes.

Plastic Sheathing Membranes

Plastic sheathing membranes are increasingly replacing the tar-impregnated felt papers used in the past. But in spite of the popularity of plastic membranes, no standard exists yet by which to evaluate these products for performance reliability.

Do we need another standard? It would be good to know if the product is going to do what it is supposed to do, otherwise it would be a waste of time and money. Canadian Construction Materials Centre (CCMC) has developed performance criteria by which the membranes can be tested to see if they meet to the intent of the Code. The properties evaluated include:

- pliability
- tensile strength of the material when new and after accelerated aging,
- water vapour permeance of original material and after accelerated aging.

A sheathing membrane works well if it allows water vapour to pass through and provides a secondary protection against water infiltration. During testing the products are subjected to a water vapour permeance test to see if water vapour passes through. Next, the product undergoes freeze-thaw cycling. During this test, the fabric of plastic sheathing membranes usually becomes more porous and the water vapour permeance increases. This is acceptable, as long as it does not lead to water infiltration.

A water ponding test helps assess water infiltration properties. The aged sample is subjected to a one inch head of water for five days. To be acceptable, the membrane must prevent any passage of water.

To check on durability, the plastic sheathing membrane is subjected to ultraviolet (UV) radiation and heat aging. The accelerated aging by UV exposure and heat simulates plastic degradation. The UV-exposed and heat-aged products have to retain at least 85% of their original tensile strength. Only products which contain adequate UV inhibitors and antioxidants will be acceptable.

Are Sheathing Membranes Air Barriers?

To qualify as an air barrier, sheathing membranes have to form an impermeable, structurally adequate barrier to air infiltration. As an air barrier, it would also have to be continuous over the building envelope and be durable. These properties would form the basis for CCMC's evaluation criteria in considering plastic sheathing membranes as air barriers.

At the moment, plastic sheathing membranes have been looked at only as secondary protection systems against water infiltration behind the cladding, the primary protection for the wall assembly. Although plastic sheathing membranes could be considered air barriers, CCMC has not yet evaluated any plastic sheathing membranes for this function as materials evaluations are only done at the request of suppliers or manufactures.

CCMC has evaluated four different plastic sheathing membranes, but only one has undergone UV and heat-age testing. The other three are scheduled for re-evaluation soon.

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